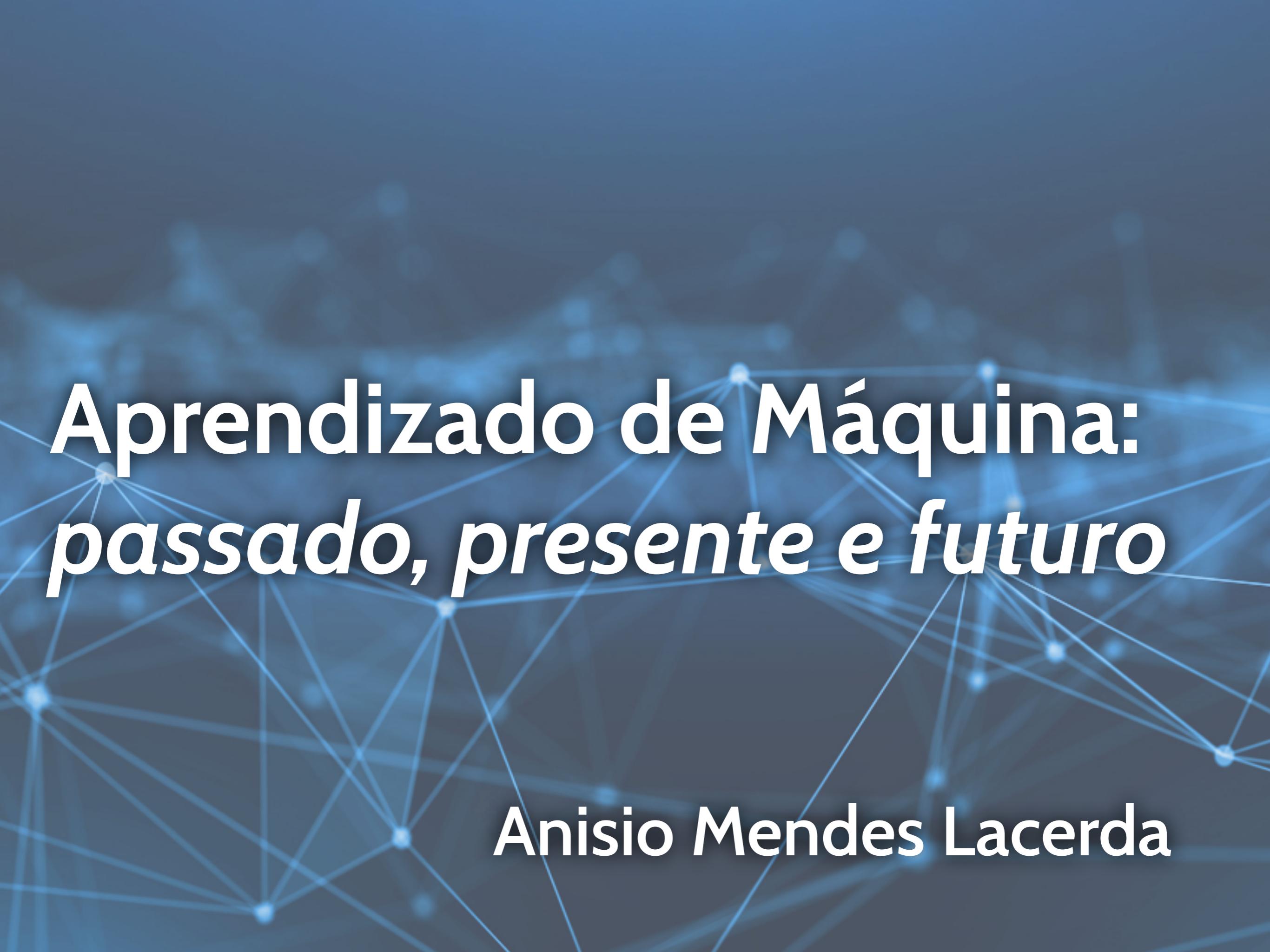


Aprendizado de Máquina: *passado, presente e futuro*



Anisio Mendes Lacerda



PhD

Universidade Federal de Minas Gerais (UFMG)

Pesquisador Visitante

Carnegie Mellon University (CMU)

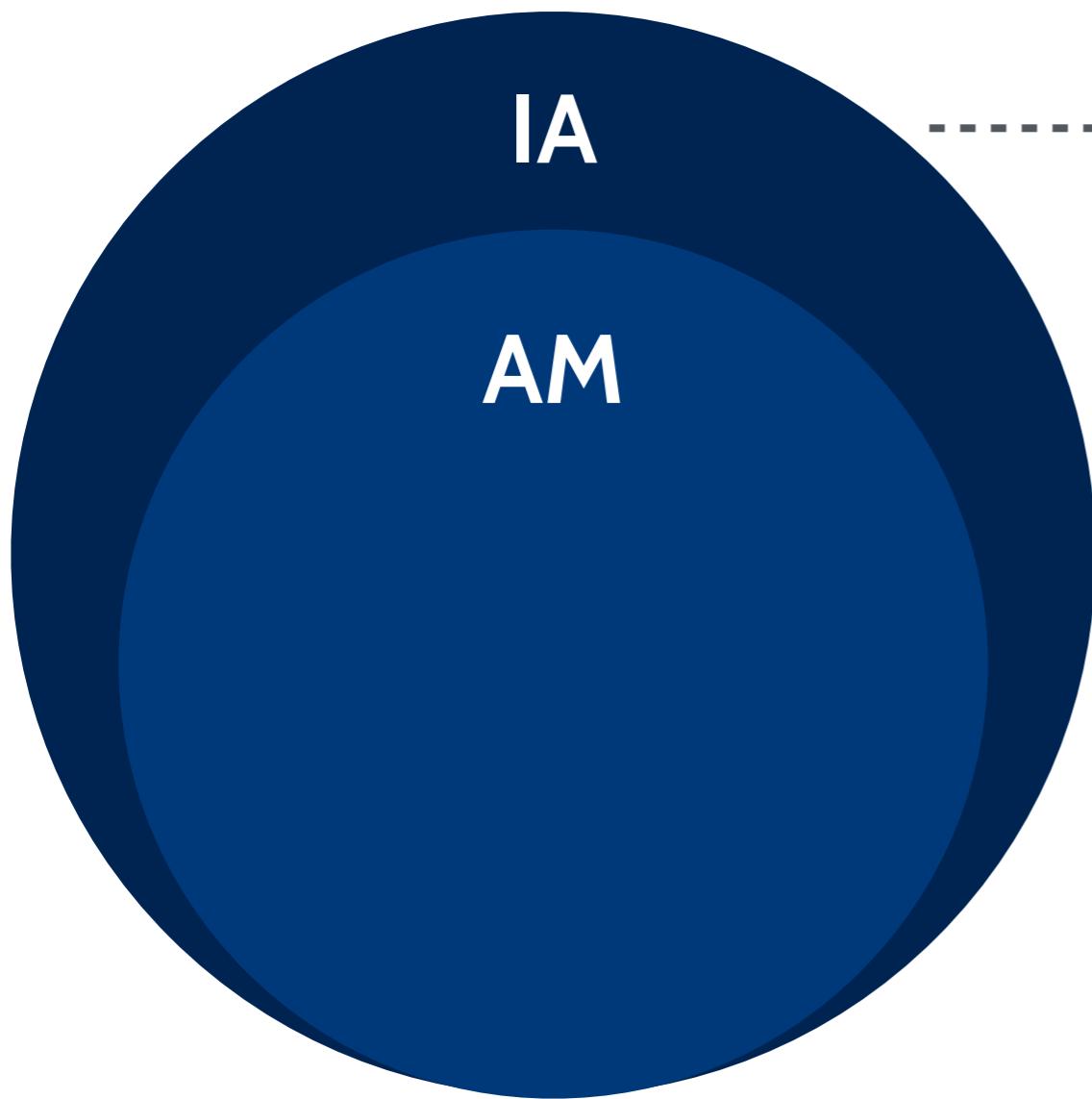
Professor efetivo

*Centro Federal de Ensino Tecnológico de
Minas Gerais (CEFET-MG)*

Bolsista de Produtividade

CNPq

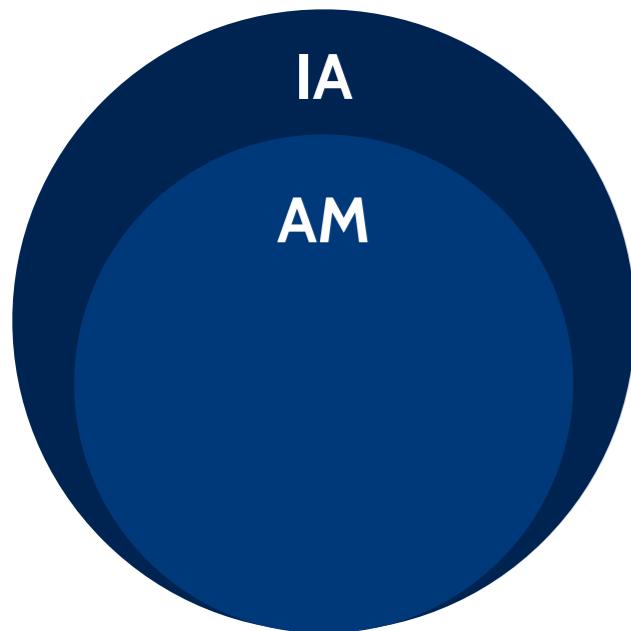
IA vs AM



Inteligência Artificial
Imitação

Aprendizado de Máquina
Dados

Inteligência artificial



- **Visão computacional**
Percepção visual
- **Análise do discurso**
Percepção sonora
- **Robótica**
Automação de tarefas
- **Aprendizado de Máquina**
Dados

Aprendizado de máquina

Programação "tradicional"



Aprendizado de máquina

Programação "tradicional"



Aprendizado de máquina

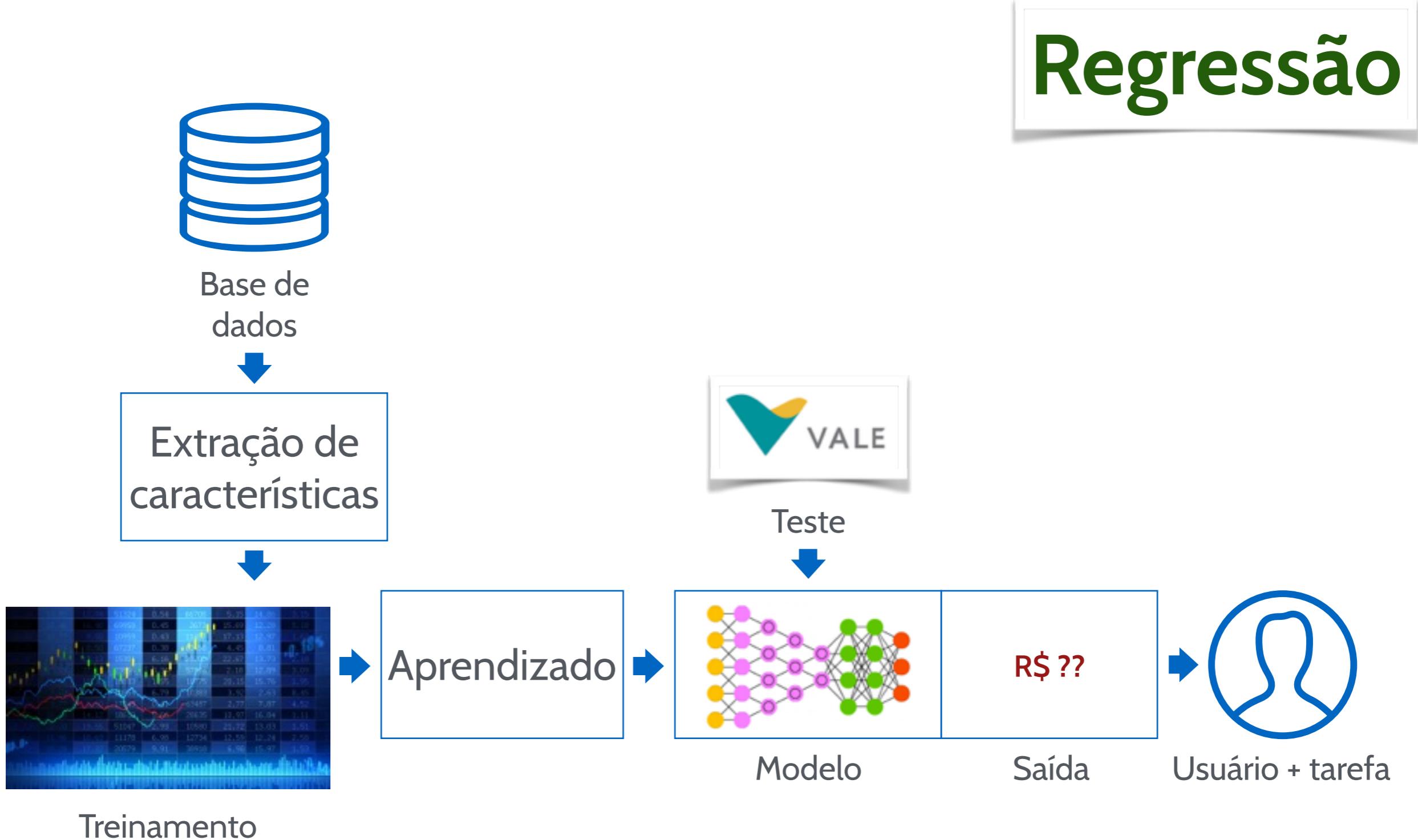


Aprendizado de máquina

Classificação



Aprendizado de máquina



Passado



“[Machine learning is the] field of study that gives computers the ability to learn without being explicitly programmed.”

Arthur Samuel (1956)

Aprendizado de máquina

Teste de Turing (1950)

Testar a "inteligência"

Primeiro programa (1957)

Jogo de Damas

KDA-2-DDA (1990)

Data-driven analysis

Dartmouth workshop (1956)

Primeira conferência em I.A.



Logic-based learning (1981)

Análise de dados por meio de
regras para excluir dados
irrelevantes

Deep learning (2006)

Imagens, sons, textos, ...

Presente

Porque agora?

- *Volume de dados*
- *Poder computacional*
- *Algoritmos*

The Big Data Universe, 2016

Amount of data stored in Petabytes
(1 Petabyte = 1 000 000 GB)

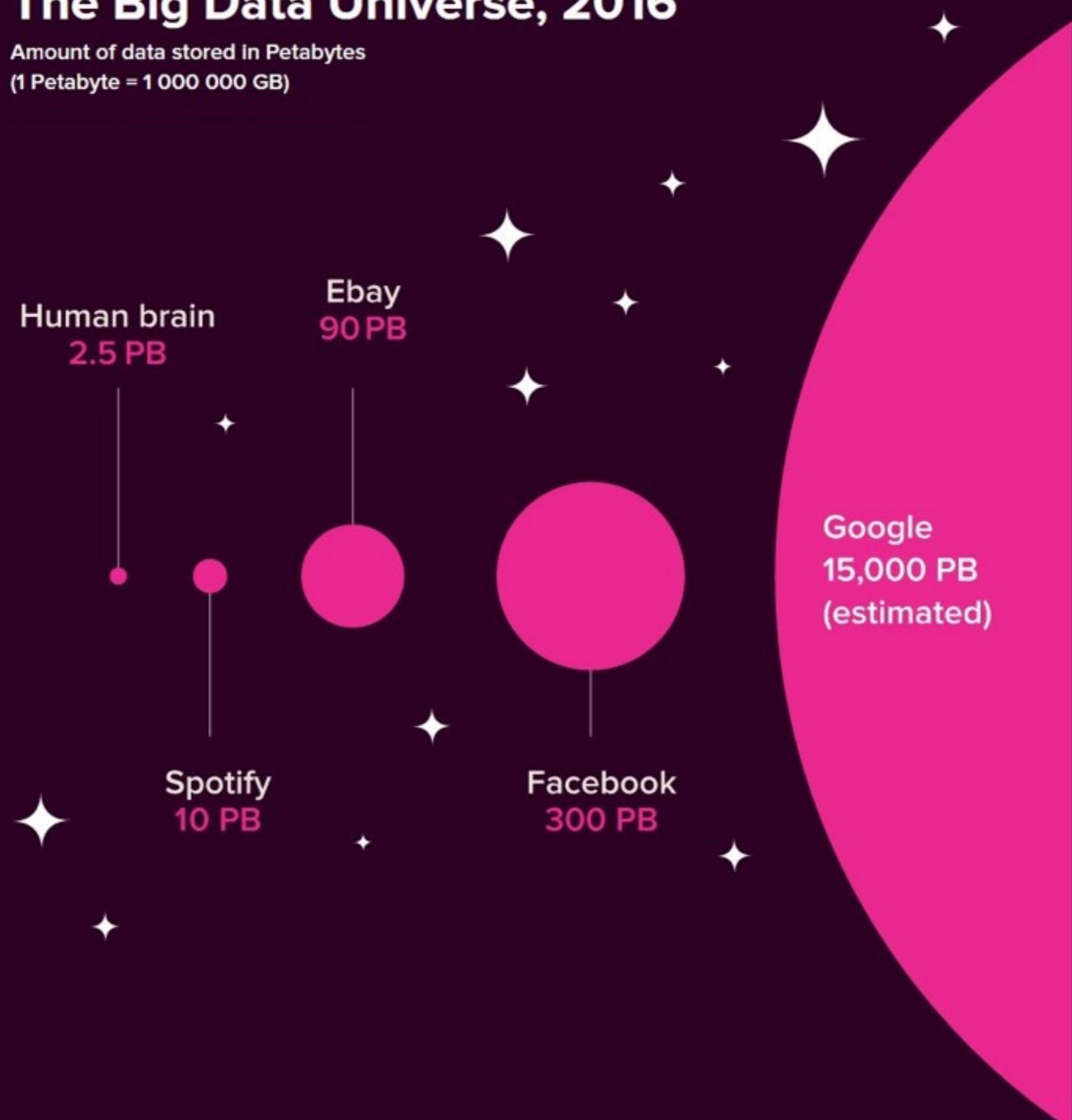
Human brain
2.5 PB

Ebay
90 PB

Spotify
10 PB

Facebook
300 PB

Google
15,000 PB
(estimated)



Porque agora?

- *Volume de dados*
- *Poder computacional*
- *Algoritmos*



- 16k processadores
- 10M vídeos
- 1B conexões
- 3 dias

Diagnóstico Médico

Análise de tumores em imagens

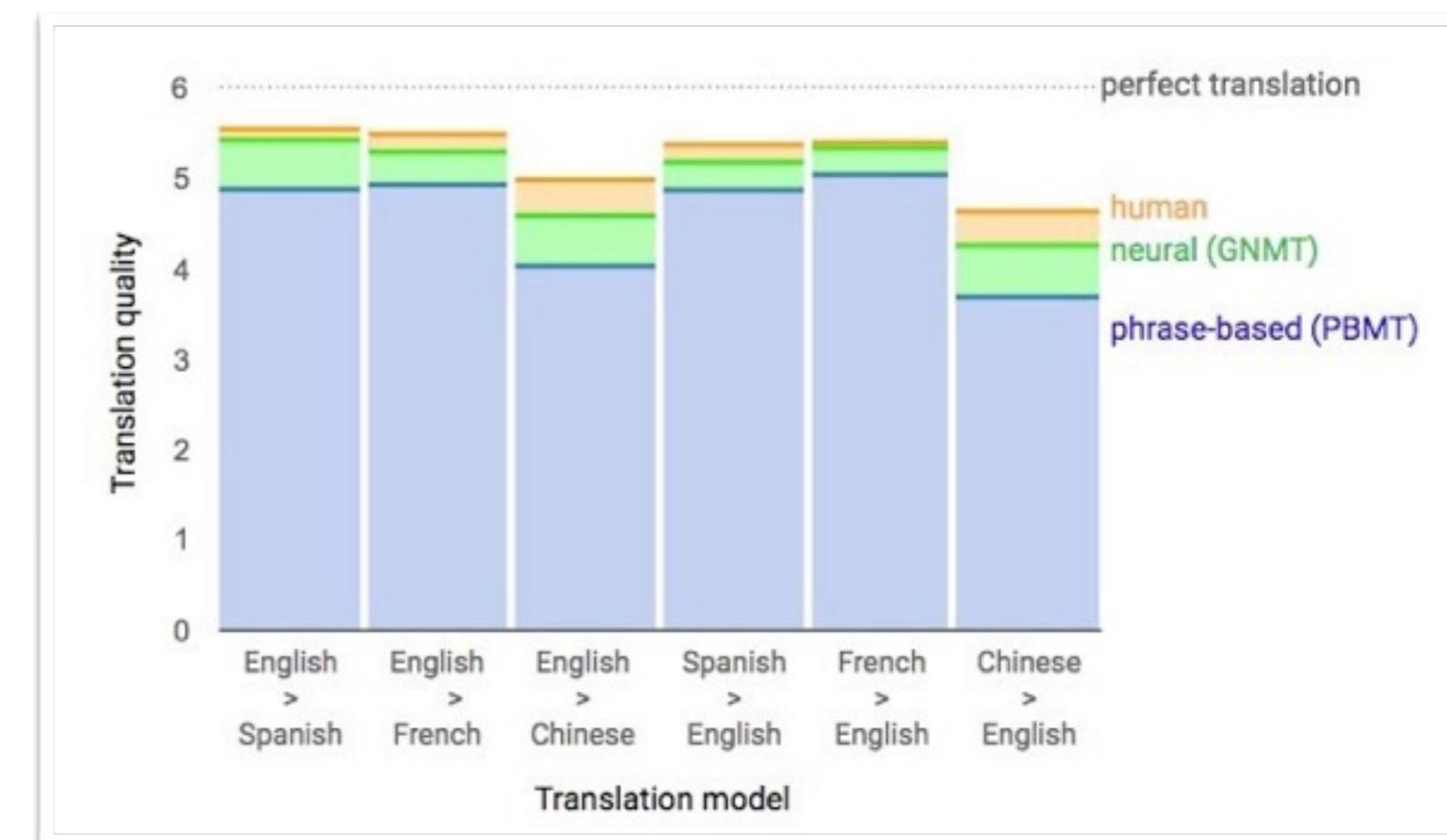
Médicos: 87%

CNN: 95%



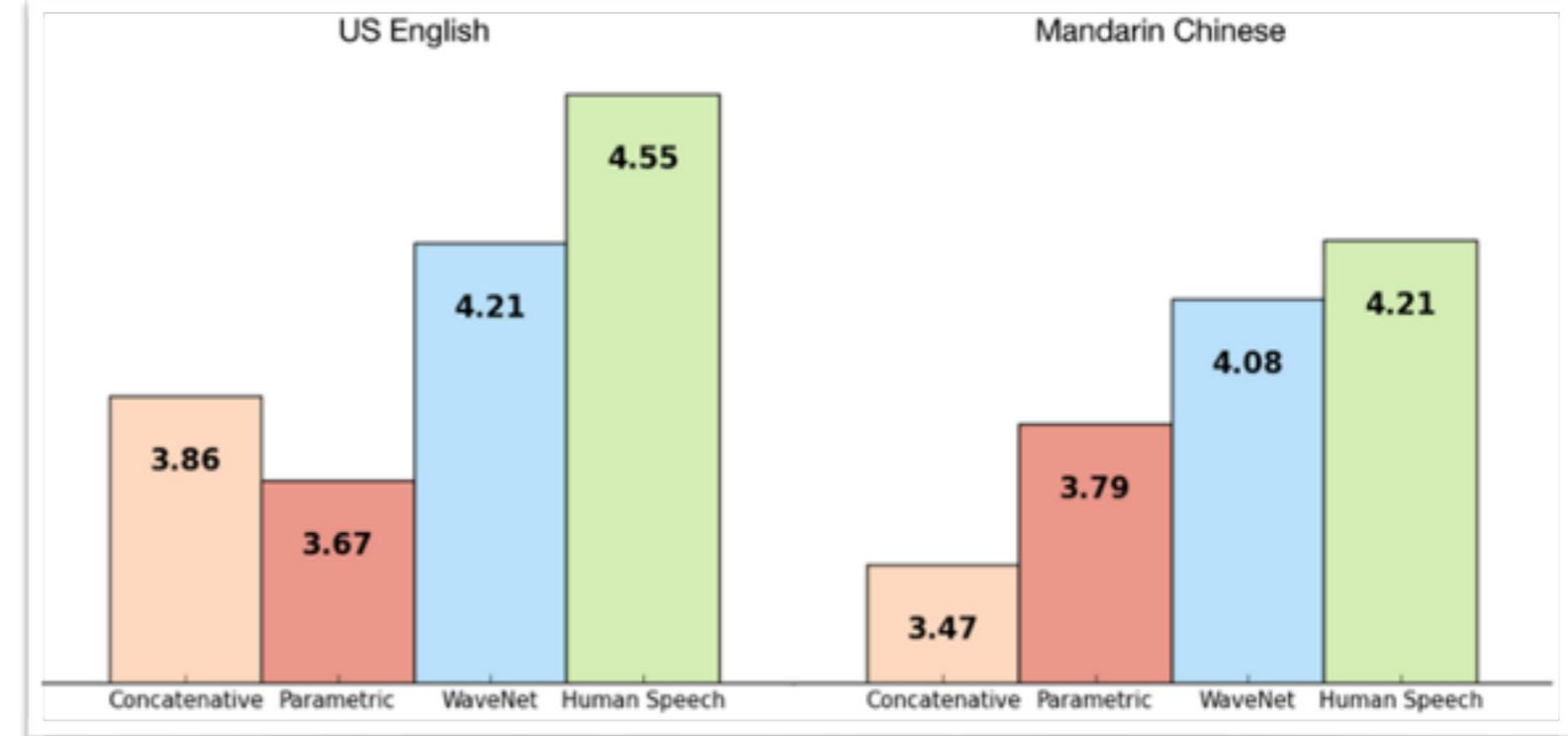
Processamento de linguagem natural

● *Tradução automática*



Processamento de linguagem natural

● *Geração automática de sons*



Veículos autônomos



Personalização

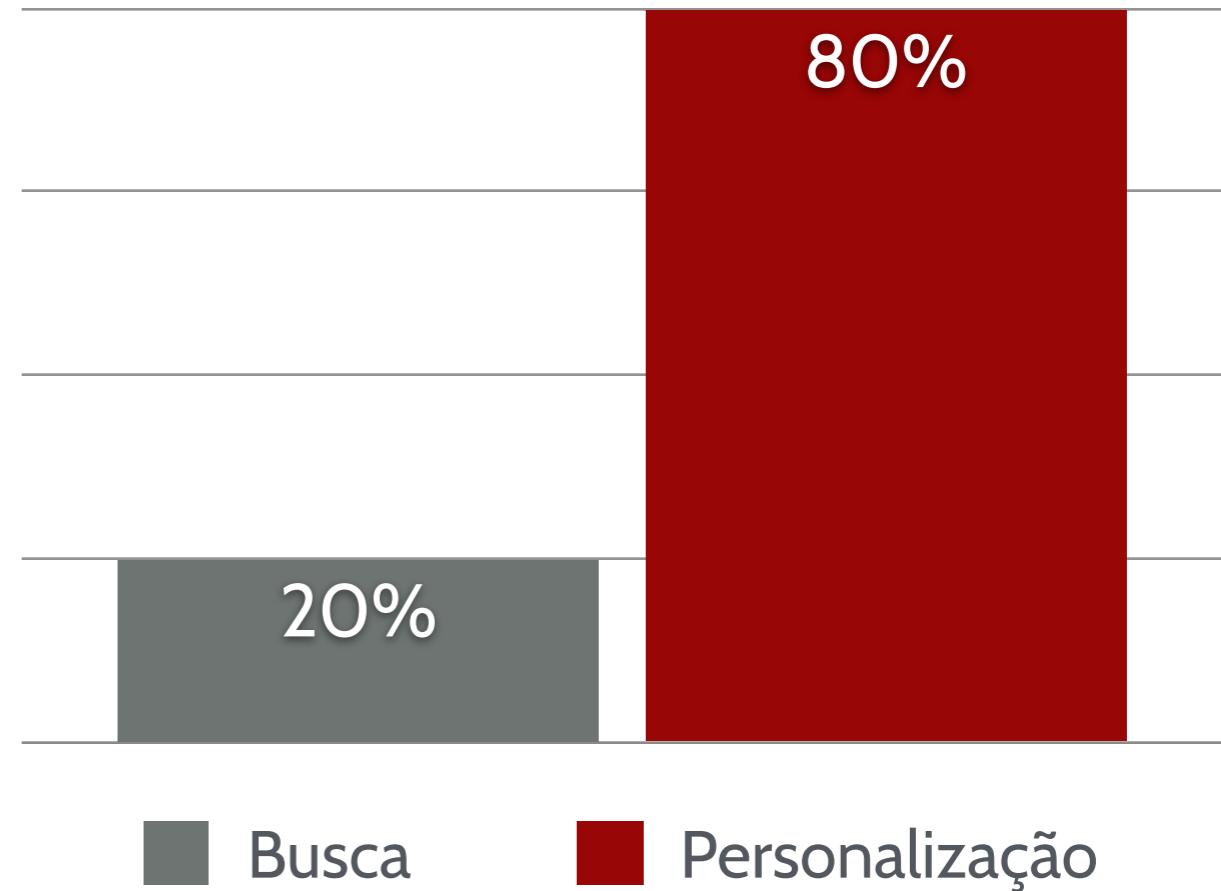
NETFLIX

Personalização

Análise de comportamento/preferências

Horas assistidas

US\$ 1 bilhão por ano



Futuro

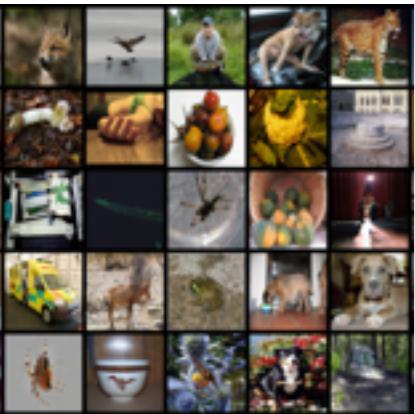
Premissas

Volume de dados

Poder computacional

Algoritmos

● Imagenet



- 14M *imagens*
- 27 *classes*
- +21k *sub-classes*

● GPUs

● RBMs, CNNs, RNNs, ...

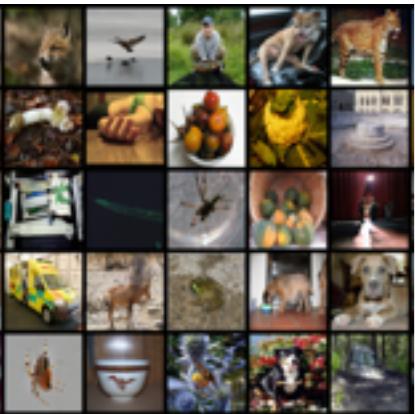
Premissas

Volume de dados

Poder computacional

Algoritmos

● Imagenet



- 14M *imagens*
- 27 *classes*
- +21k *sub-classes*

● GPUs

● Alto custo

● RBMs, CNNs, RNNs, ...

● Difícil parametrização

● Caixa-preta

● Rótulos = caros

● Few-shot learning

Próximos passos



Few-shot learning

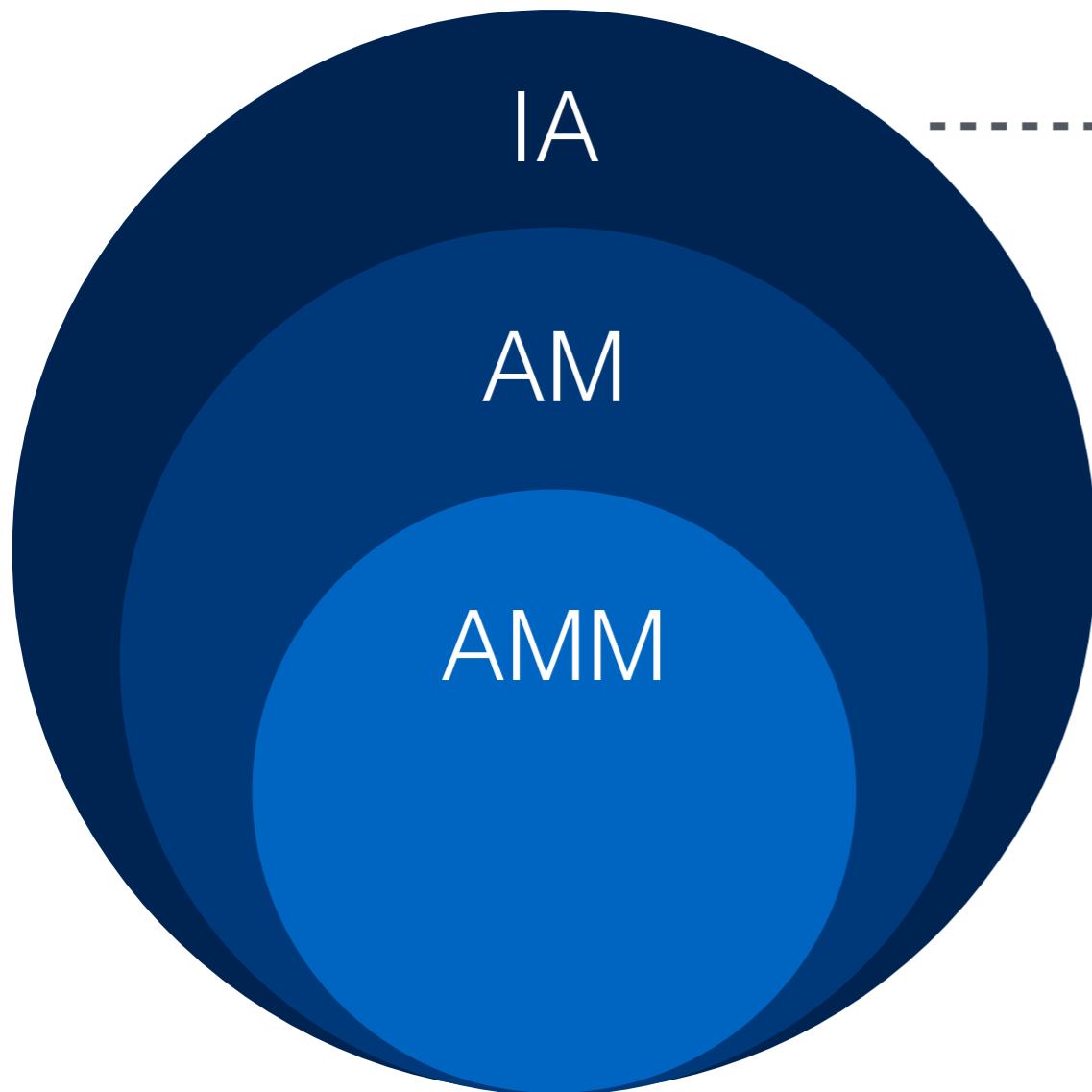
Complementariedade



Interpretabilidade

Capacidade de um ser humano entender uma predição

Sistemas de recomendação



Inteligência Artificial
Imitação

Aprendizado de Máquina
Dados

Sistemas de Recomendação
Filtragem personalizada

44,000,000

MESSAGES PROCESSED

486,000

PHOTOS

MORE THAN

21,000,000

MESSAGES SENT

MORE THAN

195,000

MINUTES OF AUDIO CHATTING
ON WECHAT

MORE THAN

69,500

HOURS OF
VIDEO WATCHED
ON NETFLIX

NETFLIX



MORE THAN
95,000
APPS DOWNLOADED
ON ANDROID

MORE THAN
48,000
APPS DOWNLOADED
ON IPHONE



AROUND
56,000
PHOTOS
UPLOADED

9,800
ARTICLES PINNED
ON PINTEREST

MORE THAN
280,000
SNAPS SENT
ON SNAPCHAT

26
NEW REVIEWS
POSTED ON YELP

120
NEW ACCOUNTS
OPENED ON
LINKEDIN

MORE THAN
140
SUBMISSIONS
ON REDDIT

MORE THAN
2,315,000
SEARCHES

3,125,000
 243,055



Share
MORE THAN
3,000,000
ITEMS ARE
SHARED

972,000
DAILY SWIPES
ON TINDER



MORE THAN
150,000,000
E-MAILS ARE SENT

GO-Globe™
CUSTOM WEB DEVELOPMENT



MORE THAN
430,000
TWEETS SENT

MORE THAN
2,700,000
VIDEO VIEWS AND
139,000 HOURS
OF VIDEO WATCHED

MORE THAN
100
NEW DOMAINS
REGISTERED

14 NEW
SONGS ADDED
ON SPOTIFY

MORE THAN
300 HOURS
OF VIDEO ARE UPLOADED

MORE THAN
280,000
SNAPS SENT
ON SNAPCHAT

MORE THAN
39,300
HOURS OF MUSIC
LISTENED

[Look inside](#)

EINSTEIN
His Life and Universe

WALTER ISAACSON

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Einstein: His Life and Universe Paperback – May 13, 2008
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By the author of the acclaimed bestsellers *Benjamin Franklin* and *Steve Jobs*, this is the definitive biography of Albert Einstein.

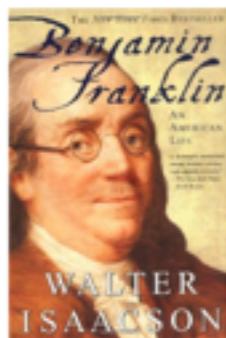
How did his mind work? What made him a genius? Isaacson's biography shows how his scientific imagination sprang from the rebellious nature of his personality. His fascinating story is a testament to the connection between creativity and freedom.

Based on newly released personal letters of Einstein, this book explores how an imaginative, impudent patent clerk—a struggling father in a difficult marriage who couldn't get a teaching job or a doctorate—became the mind reader of the creator of the cosmos, the locksmith of the mysteries of the atom, and the

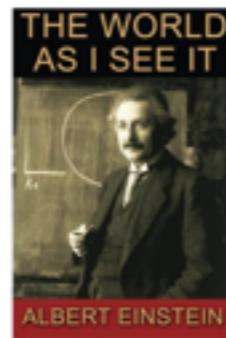
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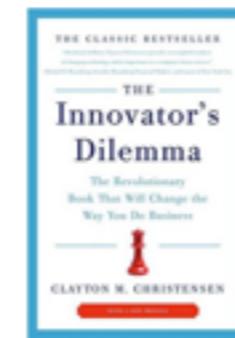
Page 1 of 17



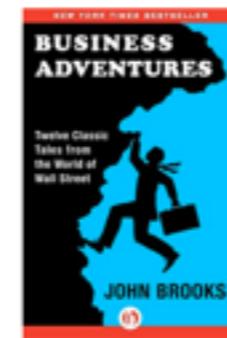
[Benjamin Franklin: An American Life](#)
Albert Einstein
Walter Isaacson
4.5 out of 5 stars 614
Paperback
\$11.90



[The World As I See It](#)
Albert Einstein
4.5 out of 5 stars 21
Paperback
\$5.99



[The Innovator's Dilemma: The Revolutionary Book That Will Change the...](#)
Clayton M. Christensen
4.5 out of 5 stars 227
#1 Best Seller in Development & Growth
Economics
Paperback
\$10.11



[Business Adventures: Twelve Classic Tales from the World of Wall Street](#)
John Brooks
4.5 out of 5 stars 311
#1 Best Seller in Commerce
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\$13.23



[The Innovators: How a Group of Hackers, Geniuses, and Geeks...](#)
Walter Isaacson
4.5 out of 5 stars 940
Paperback
\$16.19

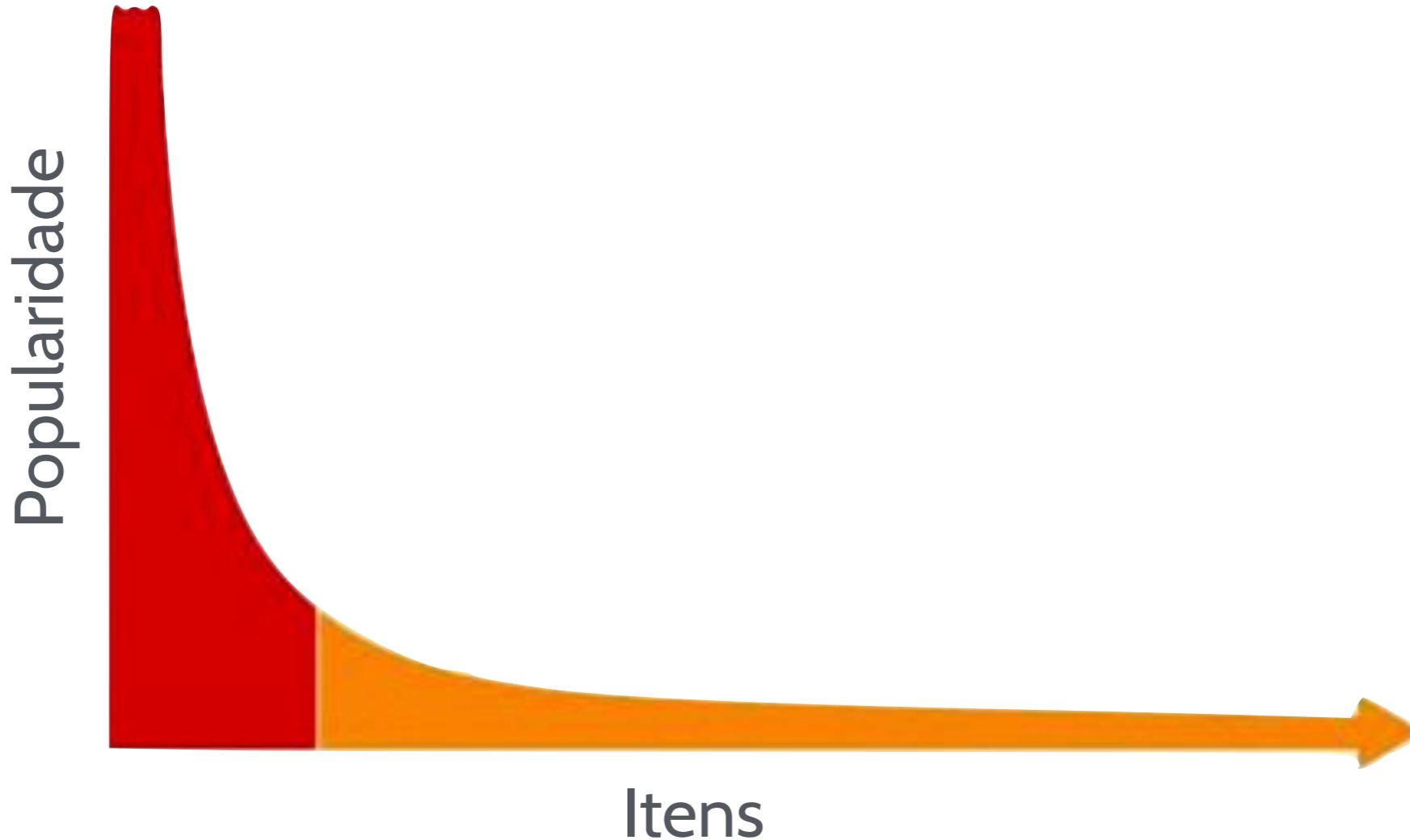


[Steve Jobs](#)
Walter Isaacson
4.5 out of 5 stars 5,075
Paperback
\$11.90





Few-shot learning



Cauda-longa

- *maioria dos usuários avaliam poucos itens*
- *maioria dos itens são avaliados por poucos usuários*

Próximos passos



Few-shot learning

Complementariedade



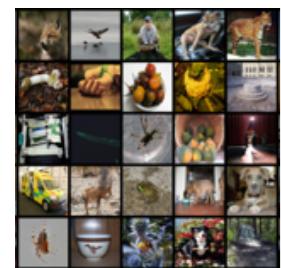
Interpretabilidade

Capacidade de um ser humano entender uma predição

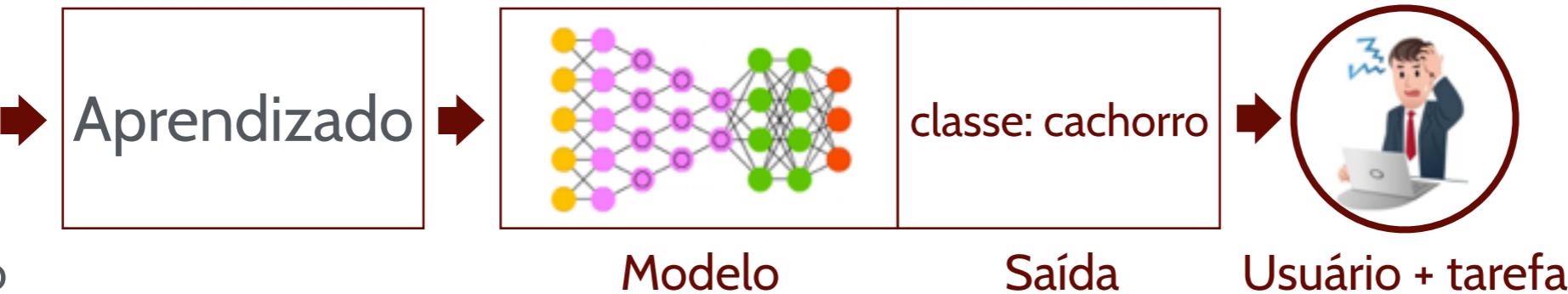


Interpretabilidade

Hoje



Treinamento

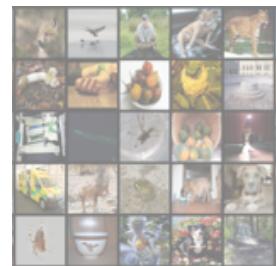


- Pq essa classe?
- Pq não outra?
- Quando acerta?
- Quando erra?
- Como corrojo erros?

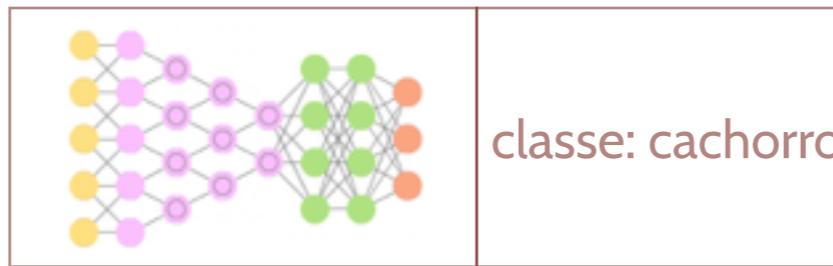


Interpretabilidade

Hoje



Aprendizado



classe: cachorro

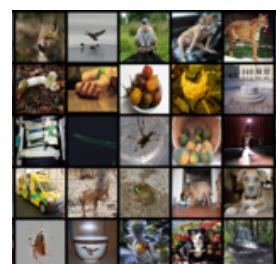


Usuário + tarefa

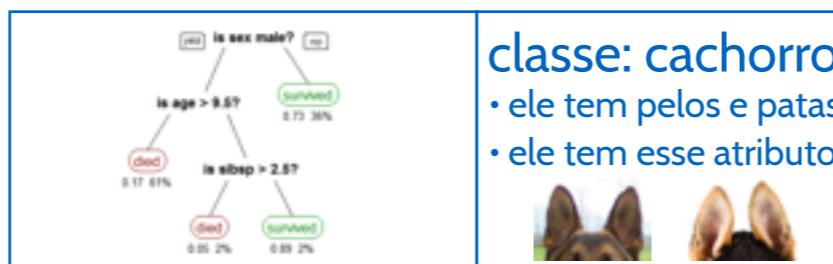
- Pq essa classe?
- Pq não outra?
- Quando acerta?
- Quando erra?
- Como corrojo erros?

Treinamento

Futuro



Novo
aprendizado



classe: cachorro

- ele tem pelos e patas
- ele tem esse atributo:



Usuário + tarefa

- Eu entendo o pq
- Eu entendo o pq não
- Eu sei onde acerta
- Eu sei onde erra
- Eu sei pq erra

Treinamento

Modelo
interpretável

Saída
descritiva



Interpretabilidade



Confiança e transparência do modelo

- Posso confiar nas decisões do modelo?
- Pq o modelo fez estas previsões?



Melhoria do modelo

- Generalização
- “Testes de sanidade”



Prevenção de “viés”

- *Fairness*
- Identificação e prevenção de “viés” discriminatório



Interpretabilidade

Right to explanation

Direitos dos cidadãos afetados por algoritmos de aprendizado de máquina



União européia

- General Data Protection Regulation
- “[...] the controller shall provide [...]”
- the existence of automated decision-making and [...]
- meaningful information about the logic involved [...]
- 25 de maio de 2018



Estados Unidos

- Equal Credit Opportunity Act
 - [...] creditors are required to notify applicants of action taken in certain circumstances, and such notifications must provide specific reasons [...]“



Brasil

- PLS 330/13
 - “solicitação de revisão de decisões tomadas unicamente com base em tratamento automatizado de dados [...]”
- PL 5276/16
 - “o titular dos dados tem direito a solicitar revisão, por pessoa natural, de decisões tomadas unicamente com base em tratamento automatizado de dados pessoais que afetem seus interesses [...]“

A few quotes...



“A breakthrough in machine learning would be worth ten Microsofts”

Bill Gates, Microsoft



“Machine learning is the next Internet”

Tony Tether, Former DARPA Director



“Machine Learning is the hot new thing”

John Hennessy, Former Stanford President

Pesquisa



Few-shot learning

Complementariedade



Interpretabilidade

Capacidade de um ser humano entender uma predição

anisio@cefetmg.br

Refs

<https://www.cbsnews.com/news/ai-better-than-dermatologists-at-detecting-skin-cancer-study-finds/>

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The Netflix Recommender System: Algorithms, Business Value, and Innovation

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